

DECALCIFICATION OF TEETH AND BONES, AND REGENERATION OF BONE THROUGH DIET*

PERCY R. HOWE, D.D.S.

Assistant Professor of Dental Research, Harvard University; Chief of Research Laboratory, the Forsyth Dental Infirmary for Children
BOSTON

That the teeth and bones are similar in structure has been recognized by nearly all physiologists. Chemically they are very much alike. According to Hoppe-Seyler, the inorganic constituents are the same

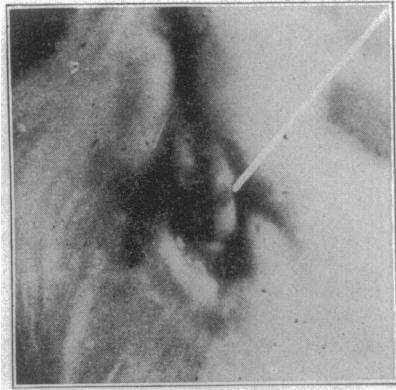


Fig. 1.—A condition similar to dental caries in incisors of guinea-pig.

for bone and for dentin, about 85 per cent. calcium phosphate and from 10 to 12 per cent. calcium carbonate. The density of dentin cartilage is about equal to that of bone.

The processes of calcification are analogous. In the teeth the calcification occurs about the processes of the odontoblasts, just as in bone it occurs about the bone cells and forms lacunae. In both, the inorganic constituents are laid down in a colloidal matrix. It would

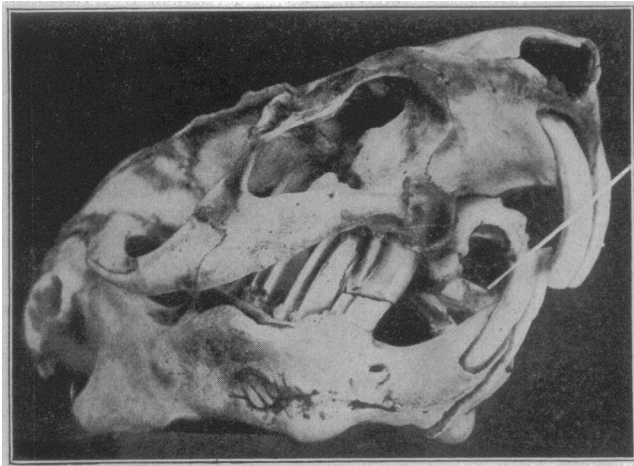


Fig. 2.—Decalcification of molars with masses of enamel attached.

therefore seem reasonable to infer that a pathologic condition which affected one might affect the other.

This, however, has not been the opinion of dentists. They believe that dental caries is a purely local affair. The present theory is that carbohydrate material adheres to the teeth and, there fermenting, with the

formation of lactic acid, forms the cavity of tooth decay. This idea has not been supported by animal experimentation. Twenty guinea-pigs, fed on a diet to which were added large amounts of sugars, viz., dextrose, levulose, lactose, saccharin, dextrin and white flour, showed no dental effect at the end of a year. The sugars and starches adhered to the teeth constantly, and bacterial examination disclosed a fermentative flora; but no dental effects could be detected.

In pathologic conditions of the bone, such as osteomalacia, Levy showed that "the normal relation of 6 PO_4 : 10 Ca is retained in all parts of the bone, which would not be the case if the bone-earths were removed by an acid. . . . In osteomalacia the exhaustion of the bone takes place by a decalcification in which one molecule of phosphate-carbonate is removed after another."

Gassman noted that in rachitic bone the calcium (Ca), phosphate (PO_4) and carbon dioxide (CO_2) relation was not changed. While different investigators have given different findings, many have shown an



Fig. 3.—Irregularity of teeth, decalcification, and absorption of alveolar process, caused by fourteen weeks of scorbutic diet. Note changes in the enamel.

increase of magnesium in pathologic decalcification of bone. In an analysis of sections from fifty teeth, twenty-five of which were from sound teeth and twenty-five from teeth which showed decay, there was about twice as much magnesium in the carious teeth as in the sound teeth.

METHOD

A cross section of about 1 mm. thickness of the root is selected as near as possible to the enamel border. The cementum and the pulp are removed. The whole section is washed thoroughly in water and dried at 100 C. for twenty hours, cooled in a desiccator and weighed, and burned in a platinum crucible for eight hours. The ash is dissolved in about 15 c.c. half-normal hydrochloric acid. Twenty-five cubic centimeters of this solution is taken for the determination, which is carried out by Kramer's titration method.¹

Duplicate analyses were also carried out by Briggs' colorimetric method.

The magnesium content is estimated in milligrams. The average percentage of magnesium in fourteen teeth from scorbutic guinea-pigs was 2.881. The average

* Read before the Section on Stomatology at the Seventy-Third Annual Session of the American Medical Association, St. Louis, May, 1922.

1. Kramer, B., and Tisdall, F. F.: J. Biol. Chem. 48:1 (Sept.) 1921.

percentage of magnesium from control guinea-pigs was 1.085.

Although one cannot say that dental caries is not due in part to an external process, still, according to experiments on guinea-pigs, extensive decalcification of teeth and of some parts of the bones is brought about

supplied the antiscorbutic factor, and was administered according to the experiment.

In fourteen weeks the teeth were extensively decalcified. The alveolar process was gone. The teeth were elongated and loose. The periodontal tissues showed a series of changes which ranged from a hemorrhagic condition to complete disintegration with pus formation. In young animals, on the fifteenth day, the joints were affected so that difficulty in the use of the legs was manifested. The joints were swollen and painful. Under chloroform anesthesia, marked, localized hemorrhagic areas were revealed at the knee-joints of the hind legs and wrist-joints of the front legs. The joints were much enlarged. The animals had eaten well and gained in weight. This condition disappears in a few days if orange juice is administered. In older animals this trouble occurs later. If the animals are kept in a latent scorbutic condition for some time, from seven to nine months, the femur and the tibia decalcify extensively, and during dissection pull apart at the epiphyseal line.

When these animals are fed an ample amount of antiscorbutic food, calcification occurs; large areas of newly forming bone are seen on the jaws and the leg bones show exostosis. Lipping or areas of new bone formation are found along the shaft of the bones. The cartilage may calcify, with ankylosis following.

It is to be doubted whether in all cases the recalcification is due wholly to the diet. It may be that in some cases tissue degeneration proceeds to the point of calcification. The process may be similar to that which takes place when implanted cartilage calcifies, or to that which follows ligation of the renal vessels.

However, in the present cases the initial process begins as a vascular and circulatory disturbance induced by the diet, and is rectified by improving the diet.

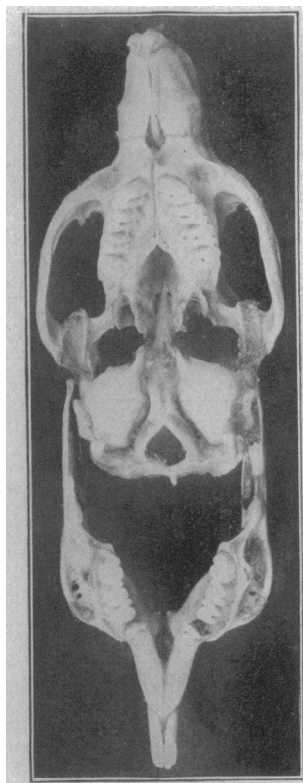


Fig. 4.—Control: regular teeth and normal bone.

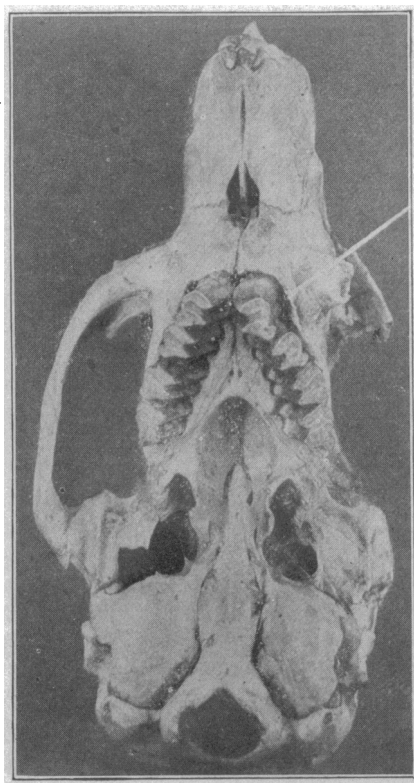


Fig. 5.—A condition similar to pyorrhea: elongation and looseness of the teeth.

by a disturbance of metabolism induced by scorbutic feeding.

The diet that was fed consisted of soy beans, 50 per cent.; rolled oats, to 100 per cent.; dried whole milk, 10 per cent.; butter, 5 per cent.; yeast, 4 per

PERCENTAGE OF MAGNESIUM IN TWENTY-FIVE ANALYSES OF SOUND TEETH AND OF DECAYED TEETH

Sound Teeth	Decayed Teeth	Sound Teeth	Decayed Teeth
0.638	1.585	0.745	0.977
0.758	0.854	0.730	1.116
0.671	1.882	0.759	0.918
0.649	1.085	0.742	0.835
0.554	0.825	0.614	1.804
0.566	0.937	0.619	1.259
0.621	1.309	0.588	1.098
0.527	1.256	0.687	0.861
0.627	1.027	0.563	1.337
0.629	1.040	0.586	1.254
0.764	1.221	0.710	1.270
0.651	0.970	0.567	1.013
0.662	1.142	Average 0.649	Average 1.154

cent.; calcium carbonate, 1.5 per cent.; sodium chlorid, 1 per cent.; agar, 2.5 per cent. The soy beans were ground and placed in the autoclave for thirty-five minutes at a pressure of 15 pounds. The various ingredients were mixed, moistened with distilled water, and rolled into thin sheets, which were dried in the sterilizer. This mixture was broken up and fed. Distilled water was given the animals to drink. Filter paper was fed for additional roughage. Orange juice

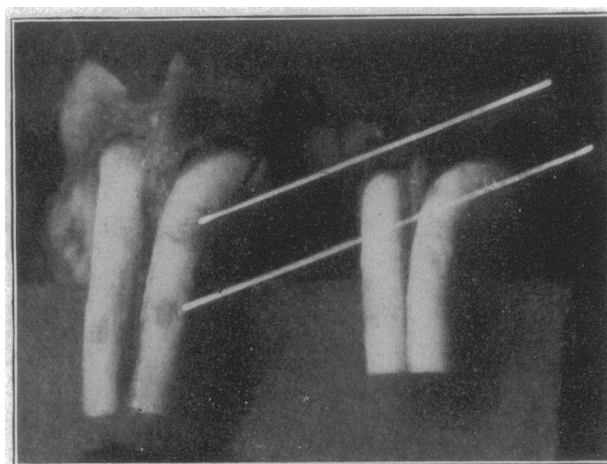


Fig. 6.—Enamel marked by alternating normal and deficient diets.

Many other pathologic or abnormal conditions occur as a result of protracted antiscorbutic deficiency which, although outside the immediate province of this paper, still are significant in the mode of action on tissue. One of these is the effect on the eye. A slight scorbutic effect on pregnant mothers has resulted, in a

number of cases, in the absence of eyes in the young. I have had several animals born with only one eye or one good eye, and the other sightless or imperfectly formed. Many are born with spots on the outer coating of the eye, which clear up under proper feeding. In animals on the scorbutic diet, eye trouble follows

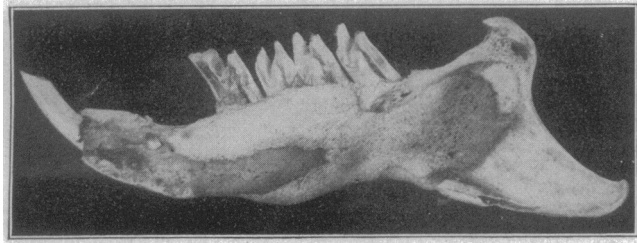


Fig. 7.—Thirty-three weeks: normal feeding about half of the time, with new bone formation.

even to the point of pus welling out over the eye during eating. Feeding orange juice is followed by complete clearing up of the trouble.

We have been working on monkeys for only about seven months, but arthritic disturbances are very pronounced; in two out of the four animals a condition resembling arthritis deformans occurs. The knee-joints enlarge to twice the normal size. The spinal column is curved, and the animal remains curled up, holding the head down. The mouth becomes filthy,

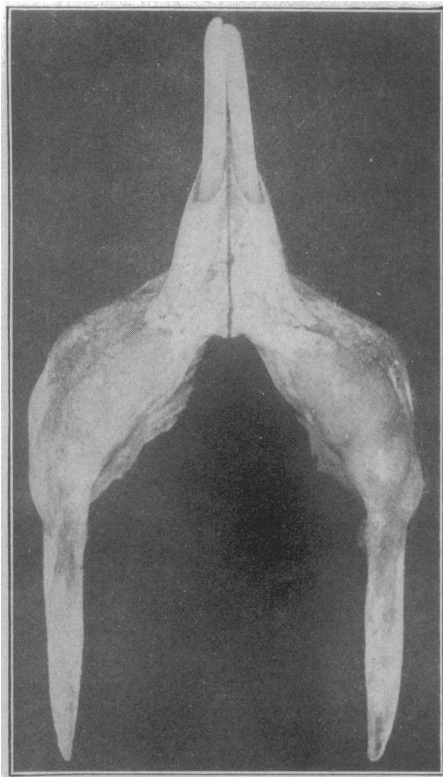


Fig. 8.—Fifty-sixth week: new bone formation complete; same series as in Figure 7.

with excessive tartar formation, and the teeth become loose.

Exophthalmos occurred in the four experimental animals; large hemorrhagic areas have appeared in the supra-orbital region and under the eye. The eyes were covered with a film in one severe case. Blood

trickled from the eye and mouth during an attempt to eat. The animal became temporarily blind. In all cases when orange juice was fed, the entire condition cleared up. If, however, the lens has become affected, it fails to clear, with the production of cataract. Cataract was so produced in one monkey and also in guinea-pigs.

The conditions described appear to be distinct from rickets. Unquestionably a proper supply of calcium and phosphorus is important, but, of the two, calcium seems to be the inorganic constituent that in modern diets is most likely to be deficient. Statistics and research indicate that the requirement, particularly for children, is greater than was formerly believed. It is well understood that calcium serves to regulate the equilibrium in almost any irregularity of the body mineral elements. But with all the proper food factors supplied except the antiscorbutic, the animal organism appears still to withdraw calcium from the teeth and some parts of the bone.

140 The Fenway.

THE EFFECT OF DEFECTIVE DIETS ON TEETH

THE RELATION OF CALCIUM PHOSPHORUS AND
ORGANIC FACTORS TO CARIES-LIKE AND
ATTACHING-TISSUE DEFECTS *

CLARENCE J. GRIEVES, D.D.S.

BALTIMORE

From its inception, dental literature has contained many statements associating food habit with oral disease. Dietary errors or excesses are said to be predisposing, if not active, causes of dental caries and gingival lesions. It is also implied that these diseases do not exist in races or individuals with correct food habits, the inference being that a proper dietary regimen will prevent oral pathologic conditions. Tangible evidence of what constitutes a correct diet is not offered by the donors of these hypotheses, which, when applied in daily routine, are not practical in the individual, whatever they may be *en masse*.

We are told that races living under primitive dietary conditions are free from oral disease: the Eskimo is said to be immune for the reason that he is essentially carnivorous, using little carbohydrate food; and the Maori, because he consumes quantities of carbohydrate and little protein food. In the midst of this exigency stands the fact that Anglo-Saxon races of all climes, with the greatest abundance and diversity of food, are being involved by oral disease to an alarming extent.

Function, or the lack of it, is said to be the pre-determining factor in the induction of these diseases. The refinement of foods, which are softened by cooking, is cited to explain the prevalence of dental disease with every advance in civilization, in spite of the fact that persons of civilized countries obtain a larger percentage of better food per capita than those of primitive races. It is asserted, for example, that just as the consumption of refined cane sugar and bolted flour increases, so dental caries increases, and

* Read before the Section on Stomatology at the Seventy-Third Annual Session of the American Medical Association, St. Louis, May, 1922.